Chem. 232 Organic Chemistry

Fall 2022

Professor Jeffrey Gustafson
JGustafson@sdsu.edu

COURSE INFORMATION

Class Days: MWF
Class Times: 10-1050
Class Location: GMCS 333 (and live streamed on zoom at 84752574414)

Office Hours: MF 11:00-11:50, W 9-950
Office Hours Location: zoom: 84752574414

Course Overview

This course covers the fundamentals of organic chemistry. The course begins by examining how periodic trends predict bonding properties and how this sharing of electrons gives rise to stable molecules. Further detailed study looks at how bonding geometry and the flexibility of chemical bonds gives rise to shape and conformation of molecules and how these properties in turn lead to the characteristics of materials. The latter part of the course will focus on how to use molecular structure to predict the chemical reactivity of organic molecules, with examples drawn from industrial process chemistry and the biological chemistry of life. The beautiful thing about organic chemistry is that it is built on a logical framework that builds upon itself as the semester progresses. Getting off to a strong start is important because every chapter builds off of itself. **Organic chemistry is a 'gateway' science to many diverse fields, including but not limited to: Medicine, molecular biology, biochemistry, consumer materials/plastics, renewable energy. food science, metabolism. A fundamental understanding of organic chemistry will prove to be an advantage in each of these fields.**

Student Learning Outcomes and schedule (this is your Final Exam Study Guide) with schedule and suggested reading:

Chapter 1: The Basics; read pp. 1–49: 8/22-8/31
1) Relate atomic structure to the number of bonds an element will form (*I.e.,* the octet rule for carbon)
2) To write Lewis structures from chemical formulas and calculate formal charges when needed.
3) Understand the existence and differences of constitutional isomers
4) Understand what resonance structures are, and how to draw contributing resonance structures form a given molecule using 'curved arrows'. Be able to rank contributing resonance structures.
6) Understand the shape of important atomic orbitals (s, p^x, p^y, and p^z orbitals).
7) Relate how atomic orbitals from different atoms come together to form bonding molecular (bonding and antibonding) orbitals.
8) Relate how bond angles predicted by VSEPR relate to the rehybridization of atomic orbitals (S and P) to SP, SP2 and SP3 orbitals.
9) Predict the hybridization of atoms in molecules based on molecular shape. Understand the correlation of bond angles and hybridization

Chapter 2: Families of Carbon Compounds; read pp. 55–99: 9/2-9/9
1) Identify common functional groups seen in carbon-based molecules
2) Identify bonds as covalent, polar covalent or ionic based on periodic electronegativity trends.
3) correlate structural features to chemical properties such as boiling point, based on the type of intramolecular interactions (*i.e.* van der Waals, dipole-dipole, Hydrogen bonding) that they can partake in.
4) identify key infrared spectra 'peaks' that corelate with key functional groups.

Chapter 3: Acids and Bases; read pp. 104–139: 9/12-9/16
1) The basics of an acid base reaction (and what conjugate acids and conjugate bases are).
2) Identify acids and bases as Bronstead or Lewis acids and bases.
3) Be able to draw a 'proton transfer' in an acid base reaction using curved arrows.
4) understand what a Ka of a reaction is, and how a Ka in water relates to the pKa of an acid.
5) understand the correlation between acid strength and pKa (lower pKa, weaker acid)
6) understand the correlation between acid strength and conjugate base strength (the stronger the acid, the weaker the conjugate base).

7) Use pKas of an acid base reaction to estimate the Ka of a given acid base reaction (the reaction will favor the side of the weaker acid; the weaker the acid, the stronger the conjugate base).
8) Understand the effect of structure (electronegativity, resonance, inductive effect, atomic radius) on acidity
9) Understand what a 'curved arrow' reaction mechanism is.

Exam 1: Exam will be released on canvas at **12:00 PM on 9/16.** You will need to complete it by **11:59PM on 9/18.** Once you start it you will have **2 hours to complete it**. You must be logged into zoom with sound and video on, and recording to cloud. A link to the recording must be uploaded to canvas under the exam assignment titled 'post your zoom for exam 1 here'. Failure to do this will result in a 0 on the exam.

Chapter 4: Nomenclature and Conformations of Alkanes and Cycloalkanes; read pp. 144–188: 9/19-9/26
1) be able to identify and name different classes of simple alkanes using 'IUPAAC' convention of nomenclature
2) Be able to draw 3-d depictions of alkanes using wedges and dashes.
3) Relate bond rotation about a sigma bond to 'conformational' energy levels.
4) Identify the different conformations that arise from the rotation of sigma bonds, and rank them according to energy
5) Identify cyclic alkanes, and relate ring size to relative stability
6) Draw 6 membered rings in '3-D chair conformation' and identify axial and equatorial substitutions, and the energetic ramifications these substitutions.
7) understand the conformational interconversion of cyclohexenes ('chair flipping')
8) identify the different stereoisomers (cis and trans) of disubstituted cycloalkanes

Chapter 5: Stereochemistry; read pp. 193–235: 9/28-10/3
1) Identify the different types of stereoisomers (geometric isomers, enantiomers, diastereomers)
2) Understand the 'spatial' concept of chirality (molecular handedness)
3) Relate to the biological ramifications of chirality
4) Assign enantiomners using the 'R' or 'S' convention

Chapter 6: Nucleophilic Reactions; read pp. 240–276: 10/5-10/14
1) Understand the reaction mechanisms of SN1 and SN2 reaction, and be able to identify the orbitals involved in these reactions
2) predict whether a transformation will undergo SN1 or SN2 type mechanism based on the structure of the electrophile and reaction conditions.
3) Understand the factors that lead to carbocation stability, and how this influence weather a reaction will undergo SN1 and SN2
3) Understand the mechanistic differences of SN1 and SN2 reactions and the stereochemical ramifications of these differences.
4) Apply the SN1 and SN2 reactions in basic syntheses.

Exam 2: Exam will be released on canvas at **12:00 PM on 10/14.** You will need to complete it by **11:59PM on 10/16.** Once you start it you will have **2 hours to complete it**. You must be logged into zoom with sound and video on, and recording to cloud. A link to the recording must be uploaded to canvas under the exam assignment titled 'post your zoom for exam 2 here'. Failure to do this will result in a 0 on the exam.

Chapter 7: Alkenes and Alkynes I; read pp. 282–327: 10/17-10/26
1) Name the geometric isomers of alkenes.
2) Identify the bonding orbitals in alkenes, and assign relative energy levels to them
3) Understand how structural aspects effect the relative stability of alkenes.
4) Understand the mechanism and orbital considerations of the E2 reaction.
5) Understand the mechanism and orbital considerations of the E1 reaction.
6) Understand the basics of the hydrogenation and dissolving metal reduction of alkenes and alkynes.
7) Apply all reactions learned in class thus far in simple syntheses.

Chapter 8: Alkenes and Alkynes II; read pp. 337–38: 10/28-11/7
1) Understand why electrons in pi bonds weak bases can be.
2) Further understand the stability trends of carbocations, and how this leads to the observed regioselectivity when an alkene reacts with a strong Acid (we call this process electrophilic addition).
3) Understand the similarities and differences between the addition of different acids and electrophiles into alkenes (HCl vs. H_3O vs. BH_3 vs Br_2 vs O_3)

Chapter 9: Nuclear Magnetic Resonance and Mass Spectrometry; read pp. 391–437: 11/9-11/11
1) Understand the basic theory of NMR and what leads to seeing a resonance (peak),
2) Understand the basic trends that determine the chemical shift of a resonance in NMR
3) Understand what leads to spin coupling, and coupling patterns, and how this can be used to interpret NMR spectra
4) Interpret simple NMR spectra.

Exam 3: Exam will be released on canvas at **12:00 PM on 11/11.** You will need to complete it by **11:59PM on 11/13.** Once you start it you will have **2 hours to complete it**. You must be logged into zoom with sound and video on, and recording to cloud. A link to the recording must be uploaded to canvas under the exam assignment titled 'post your zoom for exam 3 here'. Failure to do this will result in a 0 on the exam.

Chapter 10: Radical Reactions; read pp. 448–481: 11/14-11/21
1) Understand what a 'radical' is and the reactivity patterns and stability trends of radicals.
2) Apply the reactions of radical to the halogenation of alkanes and alkenes

Chapter 11: Alcohols and Ethers; read pp. 489–526: 11/28-12/12
1) Relate the structural aspects of alcohols, thiols and ethers to their physical properties.
2) Apply the reaction types we have previously learned in the class to the synthesis of alcohols, ethers and thiols.
3) Relate how the structure of epoxides (3 membered cyclic ethers) leads to their electrophilic reactivity.
4) Understand the synthesis of epoxides from alkenes using peracid oxidation.
5) Understand the stereochemical ramification of adding nucleophiles into epoxides.

Throughout the semester we will strive to discuss contributions from scientists from traditionally underrepresented backgrounds.

Final Exam: Exam will be released on canvas at **12:00 PM on 12/12.** You will need to complete it by **11:59PM on 12/17.** Once you start it you will have **2 hours to complete it**. You must be logged into zoom with sound and video on, and recording to cloud. A link to the recording must be uploaded to canvas under the exam assignment titled 'post your zoom for final exam here'. Failure to do this will result in a 0 on the exam.

Course Materials

Book: *Organic Chemistry*, *13e.*, by Solomons, Fryhle, and Snyder, Wiley Publ. 2016; ISBN: 978-1-118-87576-6. Available from the SDSU bookstore. **WE WILL BE COVERING CHAPTERS 1-11.**

Immediate Access Course: Some or all of the required materials for this class are provided in digital format within Canvas. The materials are available by the first day of classes and are free through the add/drop date. The SDSU add/drop deadline is at 7:59 p.m. PDT but you have until 11:59 p.m. PDT to opt out of Immediate Access. Unless you opt out of Immediate Access by 11:59 p.m. PDT on the add/drop date, your SDSU student account will then be charged the special reduced price for use of the materials for the remainder of the semester. Please visit www.shopaztecs.com/immediateaccess for additional information about Immediate Access pricing, digital subscription duration, print add-ons, opting out and other frequently asked questions.

Homework: Homework will be administered via Wiley plus. This is an immediate access course so you should have access to it already via canvas.

Lectures: The lectures and office hours will be in person, and livestreamed on zoom. Recordings will be posted on Canvas. While attending lecture and office hours are not mandatory, it is recommended to do so live.

Exams: The exams will be administered in canvas and will be a mixture of written questions (50%), multiple choice and fill in the blank. You will have 120 minutes to do the exam, and will have from Friday at 12:00 to Sunday at 11:59 to complete the exam *see schedule for exact dates*. To ensure exam security you must be logged into your personal zoom room with camera on and recording to cloud. A link to the recording must be uploaded to canvas under the exam assignment titled 'post your zoom for final exam here'. Failure to do this will result in a 0 on the exam.

Virtual Reality: Thanks to generous support front SDSU and the National Science Foundation, we will be incorporating Virtual Reality experiences into the course. There are no points tied to the VR modules, but we believe this will significantly help students understand the spatial concepts in this class (which are a major component). The final details are still pending final enrollment numbers, but students will have the option of partaking in a virtual reality lesson in the SDSU VITaL studio aimed at helping all students learn the material from a different perspective Each week there will be 1 additional office hours in the VITaL center (AH1120) from 11:30-12:30 where students can experience the VR modules guided by Professor Gustafson, or another expert in Organic Chemistry. The videos of the experiences posted on canvas for those who couldn't make it or cannot participate with VR for any reason.

Recommended (Optional) Materials:

Molecular Visions Organic Model Kit or similar organic chemistry molecular modeling set. Optional, but highly recommended.

Supplemental Instruction: Supplemental Instruction (SI) Sessions will be offered eight times each week, throughout the sixteen week course. SI is free and open to all students enrolled in this course. Participation is completely voluntary and near-peer-led, and the instructor will not know who participates.

SI Sessions are facilitated by an SI Leader who has recently successfully completed the course, and has been trained to lead active-learning-based group sessions where students can improve their understanding of course material, review and discuss important concepts, develop study strategies, and prepare for exams. Students who participate in SI Sessions typically earn higher final course and exam grades than students who do not participate, sometimes by a half to a full letter grade.

Course Structure and Conduct

This course will be taught in a traditional lecture 'chalk talk' format augmented with images as needed. Electronic homework through Wiley Plus will be due on the morning of each exam, **however it is imperative you start the homework as we cover the chapter in lecture**. It is also important that you read the book before lecture so that you are somewhat familiar with the material as I present it.

Course Assessment and Grading

Exams: Exams will be: **September 18th**, **October 16th** and **November 13th in a TBD** location from 10:00-12:00. The final exam will be on **December 11th in a TBD location**.

Exams: The exams will be administered in canvas and will be a mixture of written questions (50%), multiple choice and fill in the blank. You will have 120 minutes to do the exam, and will have from Friday at 12:00 to Sunday at 11:59 to complete the exam *see schedule for exact dates*. To ensure exam security you must be logged into your personal zoom room with camera on and recording to cloud. A link to the recording must be uploaded to canvas under the exam assignment titled 'post your zoom for exam# here'. Failure to do this will result in a 0 on the exam.

There will be three exams and one final during the semester (each exam/final is worth 250 points). All exams will be administered on canvas and will be a combination of multiple choice, matching, fill in the blank and short-answer questions. All exams are 'open note' but due to the time restraint I recommend having organized notes beforehand. All together the exams and final are worth **1000 points. If it helps your grade, your lowest exam score can be replaced with your final exam score.**

*** **There will be no make-up exams.*** ** **If you cannot make an exam your exam score will be replaced with your final exam score.**

Homework: There are 11 HW assignments administered on canvas via wiley plus, each worth **15 points**. They are due the day of the exam covering that material. Altogether the homework is worth **165 points.** ***No late homework will be accepted*** So start it early.

Extra Credit:
Memes: Students can post memes related to 232 content to the 'meme' discussion board for extra credit. Scientifically correct and topical memes will get 5 points extra credit, limited to 2 per student per exam (you can do 6 (plus a 7th for the final) over the semester for **35 points extra credit**) The memes are due no later than the Saturday ending that week. Memes must be on topics that are relevant to the next exam. This is meant to be a learning endeavor, so only student generated original content on a topic related to the lecture material will be accepted. Examples will be posted on the discussion board.

Discussion boards: Each chapter will have a discussion board where students can ask questions (think of it as a virtual office hours). Students will get extra credit for asking and answering questions. Professor Gustafson will answer questions that have not been answered. **Extra credit is up to 30 points across the semester.**

Overall grade: Your final grade will be based on a maximum of **1165**, distributed as follows: 3 exams and 1 final (1000 points) and the 11 homework assignments (165points).

Letter Grade Assignment: Depending on class performance the course may be curved, **but never downward.** If necessary, the class average will be set to a B-. 68% (the lowest B).

Tentative cutoffs:

A: 88%-100%; **A-:**85%-87.9% ; **B+:** 82%-84.9%; **B**: 72%-81.9%; **B-**:68%-71.9%; **C+:** 65%-67.9%; **C**:55%-64.9%; **C-**:50%-54.9%; **D+:** 47%-49.9%; **D:**40%--469%; **F:** below 40%

Students with Disabilities

If you are a student with a disability and believe you will need accommodations for this class, it is your responsibility to contact Student Disability Services at (619) 594-6473. To avoid any delay in the receipt of your accommodations, you should contact Student Disability Services as soon as possible. Please note that accommodations are not retroactive, and that accommodations based upon disability cannot be provided until you have presented your instructor with an accommodation letter from Student Disability Services. Your cooperation is appreciated.

Academic Honesty

The University adheres to a strict policy regarding cheating and plagiarism. These activities will not be tolerated in this class. Become familiar with the policy (http://www.sa.sdsu.edu/srr/conduct1.html). Any cheating or plagiarism will result in failing this class and a disciplinary review by Student Affairs. ***Please also note that we are aware that external tutors and websites such as 'Chegg' provide 'study packets' with old exam keys from Professor Gustafson. Obtaining these is considered academic dishonesty and will be treated as such!***

Examples of Plagiarism include but are not limited to:

- Using sources verbatim or paraphrasing without giving proper attribution (this can include phrases, sentences, paragraphs and/or pages of work)
- Copying and pasting work from an online or offline source directly and calling it your own
- Using information, you find from an online or offline source without giving the author credit
- Replacing words or phrases from another source and inserting your own words or phrases
- Submitting a piece of work you did for one class to another class

If you have questions on what is plagiarism, please consult the policy (http://www.sa.sdsu.edu/srr/conduct1.html) and this helpful guide from the Library:(http://infodome.sdsu.edu/infolit/exploratorium/Standard_5/plagiarism.pdf)

Labs

For the summer session, it is recommended to be enrolled concurrently in the lab (if you have not previously passed it) but is not required.

Extra help and tips for Success

Help is available in a variety of forms.

- **Come to my office hours**
- Work with your classmates on difficult material.
- Talk to your laboratory TA.
- Get a tutor. The Chemistry office (GMCS 209) or I can also help you to find one.
- These are also chemistry tutors available at the math and stats learning center.
- Attend SI
- Ask questions on the class discussion boards on canvas.

Advice to effectively learn the material:

Attend lectures. Effort leads to growth. Not all study strategies work for everybody so find an effective study strategy that works for you. Some suggestions are below:

- Attend lectures regularly or watch the lecture videos promptly. You do not want to fall behind in this class.
- Write questions down, and attend office hours, or ask them on the discussion boards.
- After each lecture reflect (maybe by typing a few sentences) on what you feel you understood, and what you feel you didn't understand. Then focus your studying to better understand your 'muddy' topics. These reflections are also empowering when you are doing the homework (when you het a question wrong, relect on why and diagnose the issue… learning from your mistakes is an empowering learning strategy.. embrace it!)
- Read material in book and notes before lecture, prior knowledge will help you become engaged in lecture and better comprehend material.
- Actively do practice problems and HW problems. This is a fast pace class, and it is every difficult to catch up if you fall behind. If you wait to exam week to the homework or practice problems, you will likely struggle (and have a really

stressful week).

- Discuss concepts with classmates, or study partner.
- Don't fall behind!
- Try to see the big picture. Organic chemistry builds upon itself. Many of the topics within a chapter are just a slight variation of something you learned.
- Be curious. Always ask why? Curiosity makes a scientist tick.
- Focus on understanding concepts, not memorization.
- Actively read tests and notes

Exams will be designed as much as possible to test your ***comprehension*** rather than focusing on rote memorization. Expect that some exam questions will include a small "twist" that will be recognizable if the concept is understood, but hard if you have only memorized. This will be completely clear; I do not intentionally use trick questions. This is an organic chemistry class; you will have to study hard!!!